



Laser synthesis of bimetallic nanoparticles by short and ultrashort lasers

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Bimetallic nanoparticles combine the properties of two distinct metals to exhibit enhanced catalytic, optical, and electronic performance. Their synergistic interactions, tunable compositions, and diverse structural configurations enable improved activity and selectivity in applications such as catalysis, sensing, energy conversion, and biomedical imaging. This study explores the synthesis of Ag/Au, Ag/Cu, and Ag/Pd bimetallic nanoparticles via laser ablation in liquid (LAL), utilizing both nanosecond and femtosecond laser sources. The choice of pulse duration plays a critical role in the ablation dynamics and subsequent particle formation. When using fs laser pulses, the rapid energy deposition facilitates the formation of nanoparticles with narrower size distributions, smaller average diameters, and a higher degree of alloying or distinct core-shell architectures. Conversely, ns laser ablation allows for more significant thermal diffusion into the target and the surrounding medium, resulting in larger particle sizes, broader distributions, and increased oxidation due to prolonged interaction with the liquid environment.

A comprehensive set of characterization techniques was employed to elucidate the effects of laser pulse duration on nanoparticle properties. UV-Vis spectroscopy provided valuable insights into the optical properties associated with nanoparticle size, shape, and composition. Transmission Electron Microscopy (TEM) offered detailed structural imaging, revealing the morphological differences and size distributions of the nanoparticles generated under fs and ns conditions. Furthermore, X-ray Photoelectron spectroscopy (XPS) enabled the elemental analysis of bimetallic systems.

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